Plowing with MOLDBOARD PLOWS

Farmers' Bulletin No. 1690

U. S. DEPARTMENT OF AGRICULTURE

Contents

Washington, D. C. Revised October 1954

For sale by the Superintendent of Documents, U. S. Government Printing Office
Washington 25, D. C. - Price 15 cents

PLOWING WITH MOLDBOARD PLOWS

By I. F. REED, *senior agricultural engineer, Agricultural Engineering Research Branch, Agricultural Research Service* [1]

The several types of plowing practiced in this country use more power than any other farm operation, and on many farms determine the size of tractor to be purchased or the number of horses that must be kept.

Plows may be of two general types—moldboard or disk. Some sweep-type tillers are called plows by the trade, but more often are considered as tillers or cultivators. This bulletin discusses moldboard plows and their use in effective clean plowing as illustrated on the cover. Disk plows are discussed in Farmers' Bulletin 1992, Disk Plows and Their Operation.

Complete deep coverage of all crop residue and other debris has proved to be one of the most effective ways of controlling the European corn borer and certain other insects that find winter shelter in the crop refuse left in the field. It is also an aid in controlling weeds and certain plant diseases. Clean plowing, where used, must be fitted into the farm program in a way that soil losses by either wind or water erosion are kept to a minimum.

Plows must be properly adjusted and in good condition or they waste power and do inferior work. The purpose of this bulletin is to present information that will aid in keeping moldboard plows in good working order, in using them most efficiently, and in selecting new equipment to replace old.

PLOWING EQUIPMENT

HORSE PLOWS

Horse-drawn plows are usually classified as walking, sulky, and gang plows. Sulkies and gangs may be either frameless (low-lift) or framed (high-lift). For a small acreage the walking plow is usually chosen. If considerable plowing is to be done, a somewhat greater investment is warranted and the sulky or gang plow may be more suitable. Where ease of operation is important the framed or high-lift plow is often preferred to the low-lift type. Ordinarily there is little difference in draft between walking and wheeled plows of the same size, since the advantage of carrying the load on wheels is offset by the greater weight of the wheeled plow and the weight of the operator.

TRACTOR PLOWS

Three types of tractor-drawn moldboard plows are in common use, namely, three-wheeled, two-wheeled, and direct-connected. Three-wheeled tractor plows are usually built for heavy duty and have relatively more clearance under the beams and between the bottoms than other types. The weight is carried on all three wheels, both when at work and when the bottoms are lifted. In the two-wheeled plows all the weight is carried on two wheels when the bottoms are lifted, though some of these plows

[1] Second revision of the original bulletin prepared by Wallace Ashby and A. H. Glaves.

are equipped with a fixed rear wheel, or rolling landside, which carries the landside pressure when plowing. They are mostly lightweight 1- or 2-bottom plows. Some plows of this type have ample clearance between the bottoms, but in others the beams have been shortened and clearance sacrificed to reduce the weight.

The tractor's drive wheels serve instead of the usual plow wheels to steady the plow and assist in regulating depth for the direct-connected-type plows. Both hand- and power-lift types are available, though few hand-lift units are now being made. The entire weight of the direct-connected plow is carried on the tractor when lifted, although it may be equipped with a rigid rear wheel or rolling landside, as used with the two-wheeled plow. Some types are equipped with a gage wheel that helps in controlling the depth of operation. Each type of direct-connected moldboard plow has adjustment arrangements peculiar to that particular plow, making it inadvisable to attempt to give general directions. The instruction books furnished by the manufacturer explain all adjustments fully. Discussions of attachments, however, will apply.

TWO-WAY PLOWS

Two-way plows, for use on hillsides, on terraced fields, and under conditions where dead furrows must be avoided, as in irrigated fields, are made for either horse or tractor power. The bottom of a two-way walking plow is hinged to the beam so that it can be turned over or turned end for end to set it to turn the soil to the right or left. Other two-way plows for use with horses or tractors have right- and left-hand bottoms that are used alternately to throw all furrow slices in one direction. Most of these are wheeled plows, but some for tractors are direct-connected, as described above.

PLOW BOTTOMS

A plow bottom is in reality a three-cornered wedge with one side a landside, one side the cutting edge of the share, and the third side a curved face called the moldboard. As this wedge is pushed forward into the soil, there is a tendency to break blocks loose. These blocks are broken or pulverized as they are bent to conform to the shape of the curved moldboard.

A great variety of bottoms have been designed and made available for different soils, soil conditions, and types of work. At one extreme is the breaker bottom for turning stiff sod or very heavy soils. It is long and low, with a gradual turn that tends to invert the furrow slice with very little pulverization. At the other extreme is the stubble-type bottom, with a rather high, short, abrupt moldboard that turns the furrow slice quickly. Between these two extremes are a great variety of general-purpose bottoms developed to meet variations in plowing conditions.

Stiff soils and tame sods require bottoms that resemble the sod type, because the furrow slice will not break down to the curvature of the more abrupt type and will either buckle or be thrown out in pieces crosswise of the furrow. On the other hand, light sandy soils require bottoms approaching the stubble type, otherwise the furrow slice may crumble and fall rather than be laid over smoothly. This bulletin deals particularly with plows equipped with general-purpose and stubble types of bottoms.

Good plowing requires a bottom suited to the soil and to the particular work to be done. It must scour, turn well-laid furrow slices, leave the soil in good condition to make

a seedbed, cover trash thoroughly, resist wear, and have minimum draft. Usually a type of bottom that has been in use in a locality for some time will be found to meet most of these requirements. Until a new type of plow bottom has proved its worth in a locality it should be purchased only after trial, preferably on the farm where it is to be used. Several manufacturers, however, are now building bottoms using simplified low-cost shares that need little or no sharpening other than grinding. Shares and points are simply replaced when worn. Because of the economy in share upkeep, bottoms of this type should be given careful consideration when new plowing equipment is purchased.

Since large plow bottoms cover trash better than small ones and abundant power is furnished by tractors or by several horses in tandem team hitches, there is a tendency in some sections to use bottoms 16 inches or more in width. These are often referred to as "big-base" plows and are designed to turn under heavy growths of green-manure crops, stalks, and trash. Some of these plows are well adapted to such use and leave ordinary mellow soil in good condition to be worked into a seedbed. Large plow bottoms do not turn hard dry soil so smoothly as do small bottoms, but this is not an objection when the land is being plowed in the fall for spring seeding.

Where soil conditions on a farm differ widely, or where different crops are to be plowed under—for example, cornstalks in one field and heavy sod in another—it may pay to have two sets of bottoms for the plow. Most manufacturers can furnish several types, which can be interchanged by removing a few bolts.

ACCESSORIES FOR CLEAN PLOWING

A plow without attachments may turn over clean stubble land quite satisfactorily; but sod land, weedy land, or land on which there is a covering of straw, manure, cornstalks, or the like may be plowed better if the plow is equipped with certain attachments. These should be selected to suit the work and to fit the plow. The attachments shown in figure 1 are suitable for plowing under cornstalks or a heavy cover crop, such as sweetclover. Since these attachments require space in which to do their work, plows for clean plowing should have ample clearance under the beams, braces, and axles. In gang plows there should be sufficient space between the moldboard of one bottom and the upright part of the beam ahead to allow the furrow slice and trash to pass without clogging. The more clearance at this point the better.

Colters

Rolling colters are used to cut roots and surface trash that might otherwise cause ragged furrows or clog the plow. They improve the work in most cases and often reduce the draft, but are not entirely satisfactory in soils containing loose stones. Colters as small as 10 inches in diameter, equipped with a curved trash guide on the front and with a small-diameter bearing mounting, often called "moon-type colters," are very effective on walking plows where large colters cannot be used because of limited clearance. For plowing in sod, 12- or 13-inch colters of the regular type may be satisfactory, but they are ineffective when used in heavy, coarse, or loose trash. Because large colters do better work and wear longer in proportion to their cost, colters at least 15 inches in diameter should be used if the plow has room to accommodate them. In heavy trash,

FIGURE 1.—Covering attachments help bury trash. Rolling colter (*a*) cuts pieces; jointer (*b*) moves roll of soil and trash toward open furrow; covering wires (*c*) guide trash under turning furrow slice.

17- or 18-inch colters are best if they can be used, as they can be set reasonably deep and still mount and cut trash that a smaller unit pushes ahead until clogging occurs. Roller bearings maintain proper alinement of the blade with less attention than is required for the cheaper types of bearings. Directions for setting the rolling colter are given on page 9.

The fin colter is often used on the walking plow in preference to the rolling colter because it is lighter and does not tend to lift the front of the plow. This type of colter consists of a flat knife blade riveted to the side of the share in an upright position just behind the point. It cuts roots satisfactorily but is not so effective as the rolling colter for handling trash. The fin colter needs little attention other than occasional sharpening.

The deflecting colter, a combination of jointer and fin colter, has been found very satisfactory for breaking new ground. Several other types of colters are made for special conditions.

Jointers

The jointer, sometimes called the skimmer, is a most important aid to clean plowing. It cuts a shallow furrow 3 to 5 inches wide, above the point of the plow bottom, turning a ribbon of sod or soil and trash toward the open furrow. As the new furrow slice is turned on edge by the moldboard, much of the trash moved by the jointer rolls to the bottom of the furrow and is covered by clean soil (fig. 1). If the jointer is not used, considerable trash protrudes from the seams between furrows.

The use of a moldboard-type jointer on a one-mule 6-inch or 7-inch plow makes it possible to turn under relatively heavy crops of

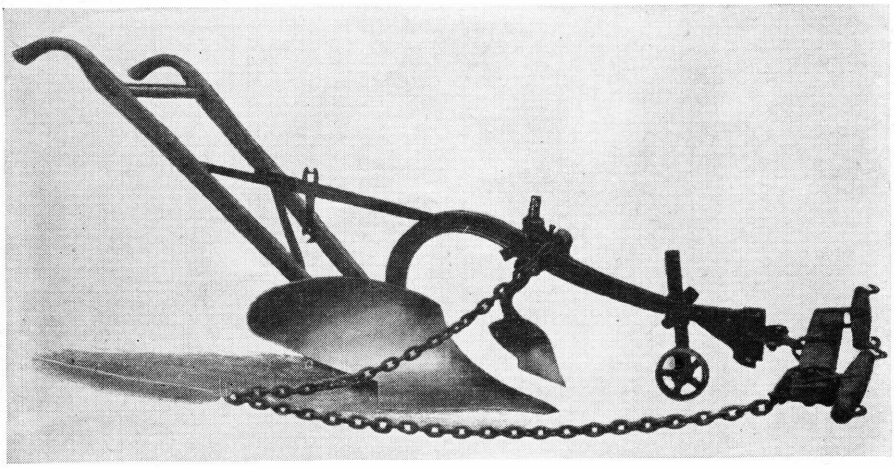

FIGURE 2.—Walking plow equipped with depth-gage wheel, jointer, and chain. A 6-foot length of No. 9 wire fastened to the loop of the chain drags under the newly turned soil. This combination is suitable for turning under moderately heavy growths of weeds, cornstalks, or cover crops.

Austrian Winter peas and other soil-building crops. The jointer parts the growing crop as effectively as a colter and in addition moves the top growth toward the open furrow. Thus, as the furrow slice is turned, this material falls near the bottom of the furrow and is almost completely covered. The use of the jointer enables farmers using small plows to handle soil-building crops satisfactorily.

The moldboard type of jointer resembles a small plow and is held in position by a shank clamped to the plow beam (independent jointer, fig. 2), or it may be held by a shank clamped to the yoke of the rolling colter (combination colter-jointer, fig. 1). The independent type is more rigid and can be used under more adverse conditions than the combination. Under ordinary soil conditions either type is helpful in plowing clean, providing the plow has sufficient clearance to allow trash to pass without clogging.

Disk jointers may be substituted for both colter and moldboard jointer. Usually they do not turn so wide a ribbon of soil as do large moldboard jointers, but it is possible to use disk jointers under some conditions where moldboard jointers will not scour. Directions for setting jointers are given on pages 9 and 10.

Chains and Covering Wires

Chains are used chiefly with walking plows and are effective in covering both weeds and loose trash (fig. 2). Covering wires are preferable for wheel plows under most conditions. They improve coverage considerably with very little cost or trouble. Directions for attaching chains and wires are given on page 10.

Other Accessories

Weedhooks are useful for covering small growth attached to the ground, but are not so effective in loose trash. Shields for deflecting trash to the bottom of the furrow are available. Some types have been used satisfactorily in a number of localities. Flat springs, shaped like sled runners and known as

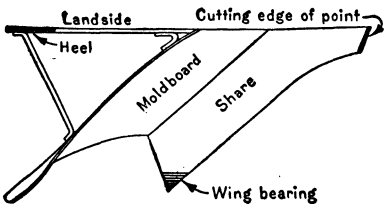

FIGURE 3.—Top view of walking-plow bottom. Heavily shaded parts on the underside of plow carry the weight when share is new. The point is set slightly "to land" to give side clearance.

broomcorn springs, are sometimes used to make trash feed under rolling colters. A special type of rolling colter for walking plows has a cast shoe that answers the same purpose.

GETTING READY FOR THE FIELD

A plow requires comparatively little care, but if it is neglected time will be wasted in the field when plowing conditions are most favorable and time is most valuable. Therefore any needed repairs should be made before the plowing season. Delays due to worn, broken, or missing parts will thus be avoided and the necessary field adjustments simplified.

Rust is the most common cause of scouring trouble, but it is easily prevented. A small can of used motor oil and an old brush or swab may be kept handy for oiling the plow bottom at night or when work is finished. This will prevent rust for a few days, but when the plow is to stand for a longer time the polished parts should be covered with a heavy grease. Nearly all oil companies make rust-preventive coatings that are especially effective for this job.

Bolts should be kept tight to avoid breakage or misalinement, which may prevent proper scouring and cause other difficulties. Axles, colter bearings, and other working parts should, of course, be lubricated regularly.

PLOWSHARES

The plowshare does the hardest part of the work and requires about half the power used by the plow. It should be kept in good condition, because a badly worn share increases draft and interferes with proper operation.

When a new walking-plow bottom is set on a flat table top or floor, the weight rests on the three points indicated by shading in figure 3. These are the cutting edge at the point of the share, the small bearing area at the wing of the share, and the heel of the landside. When the plow is at work in hard ground, most of the downward pressure is carried on the under side of the point, while the wing bearing and the landside heel assist in holding the plow bottom level. All other parts back of the cutting edge must clear the bottom of the furrow so that the plow will enter the ground freely and hold its depth.

Plowshares with points shaped about as shown in figure 4 were developed through years of field experience. This shape was found to be effective for penetrating ordinary soil and for standing rough wear. However, the high first cost of these shares and the lack of blacksmiths who could properly sharpen or repoint them prompted the development of plow bottoms

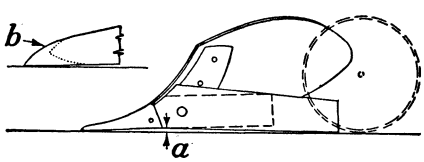

FIGURE 4.—Side view of walking plow. Solid lines show bottom fitted with full-length landside; dashed lines show how short landside would be set if rear wheel were used. Clearance (*a*) is usually termed "down suck." *b*, An enlarged view of a good point; dotted lines show how it may look after hard wear.

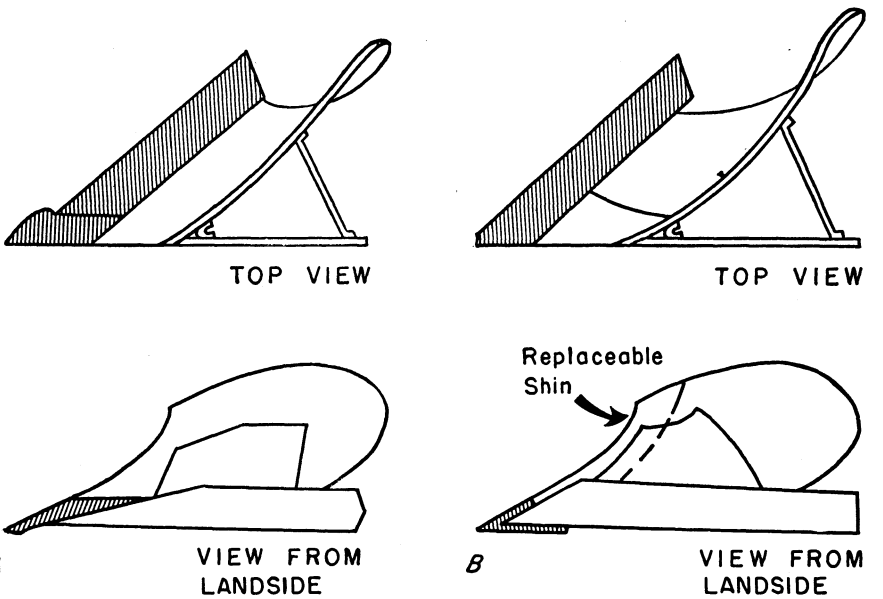

FIGURE 5.—Plow bottoms with simplified shares (shaded areas). *A*, Bottom having a two-piece share and point arrangement. Either unit can be replaced separately. *B*, Bottom having a share made of a single piece of grader blade stock cut to shape and bolted in place. A replaceable shin, as shown in *B*, is an essential feature with either of these types of shares.

using simplified shares that could be sharpened by grinding or replaced when dull. Some are made in one piece and others are made in two pieces (fig. 5). The two-piece construction makes it possible to replace the point and cutting-edge sections independently.

The clearance shown in figure 4, *a*, usually referred to as "down suck," varies with different makes and types of plows. Similar clearance at the side is called "land suck." Manufacturers' instruction books give measurements of suck for their plow bottoms. Deep-suck shares, which turn down a little more than regular shares, may be obtained for plowing hard dry ground, but points that turn down too much may make the plow gouge and run unevenly. On the other hand, when the point of the share unit wears, as shown by the dotted line in figure 4, *b*, it will not enter hard ground properly. The remedy is to replace the point of a two-piece or simplified share, or to replace or reshape the share on a conventional-type bottom, depending on the kind of material from which it is made.

The wing bearing of a walking plowshare (fig. 3) helps to keep the plow level. Too little flatness at the wing bearing will cause the plow to lean toward the open furrow, or "wing down." Too much will cause it to "wing up." One rule is that the wing bearing for a 14-inch walking plow should be 1¼ inches wide, measured toward the landside from the corner of the share. The proper wing bearing and the proper down suck of walking plows, however, depend chiefly on the conditions under which the plow is to be used. For instance, some land, if being plowed in the spring, may require an unusual amount of wing

304973°—54——2

bearing and very little down suck. If the soil is dry the same plow in the same field may need the down suck increased to as much as three-eighths of an inch, or more, and the wing bearing reduced or almost entirely removed. Local blacksmiths usually adjust the suck and the wing bearing according to conditions in their territory and the season in which the farmer is to use his plow. The wing bearing of a steel share may be changed in the field by bending it carefully with an adjustable wrench. Wing bearing is not needed in most wheeled plows, because the wheels steady the plow in the crosswise direction.

Plowshares are made of chilled cast iron, cast steel, solid steel, or soft-center steel. Chilled cast-iron shares are harder and cheaper than steel shares and are used largely in sandy or gravelly soils. These shares are hardest on the under side and therefore resist wear best where the wear is greatest. They may be sharpened by grinding off the top of the cutting edge, but cannot be changed by forging. Since they are cheap, it is better to put on a new share than to attempt to repair one that is badly worn. It is important that a new share be just like the original, for a cast share that does not fit properly will break easily. Cast-steel shares, like chilled cast-iron shares, are relatively cheap. They are fairly hard, but will not break so easily as chilled cast iron and can be used in any soil condition where they will scour. Solid-steel and soft-center shares take a high land polish and thus will scour in soils when the cheaper shares stick; the extremely hard surface of the soft-center share resists wear, yet does not break easily, owing to the soft core. Worn points and cutting edges on conventional-type shares should be reshaped by forging, but it is impossible for the blacksmith to retain all of the original wearing qualities. Simplified shares are seldom sharpened. The following instructions for sharpening steel shares are furnished by a plow manufacturing company.

Build a fire on the forge suitable for this particular work. This is done by banking the fire, allowing only a small opening in the side for the blaze and heat to escape. Commence with the point of the share. Insert this into the fire just far enough to heat the part you wish to draw, never permitting the heat to extend farther back on the share than is absolutely necessary. Draw this down to the proper shape and thickness, which should be as near the original bevel as possible. After the point has been finished, work back toward the heel or wing of the share, never heating more than 1½ inches from the edge and 2½ inches wide. It is important to keep hammering after the steel has changed from a red heat to a black, as this makes the edge tough and hard, giving a wearing surface that will last much longer.

If once down the share is not sufficient, reheat; but confine the heated part to the above measurements. In working along the cutting edge, keep it straight. In so doing you will avoid having to go back and reset the edge.

For ordinary plowing conditions the point may be reheated and chilled after the whole share has been reshaped, to give additional hardness and wearing qualities. To do this, heat about 3 inches of the point to a dull cherry red, then quench in water until cold. This treatment is not recommended for the whole share on account of the difficulty of getting an even heat and the danger of warping. If solid stones are likely to be struck it is best not to chill the point, but to depend on hammering until the share is cold to give hardness and toughness.

Sometimes a thin layer of one of the new very hard alloy metals is welded onto the point and cutting edge of a steel share with an acetylene torch or an electric arc. This increases the wearing qualities greatly, but does not materially

lessen breakage. It should be done before the share is badly worn.

Special Shares

In stony land or in dry, hard ground, where penetration is difficult, "cobblestone" shares with narrow wings that cut less than the full width of the furrow may be used on a wheeled plow. The plow, however, should still turn the same width as a standard share cuts. The "alfalfa" share for alfalfa sod is wider and flatter at the wing than standard and is set at a blunter angle to the landside, to reduce the tendency of the plow to slide around large roots. "Notch-edged" shares are also available for such purposes. Long and short shares are available for bottoms using simplified shares. Implement dealers can furnish full information about special shares for the plows they handle.

FITTING AND SETTING THE ATTACHMENTS

The following suggestions are for the care and approximate setting of the attachments. Since soil conditions largely affect the operation of both plow and attachments, final adjustments should be made in the field.

The Rolling Colter

The colter should be sharpened occasionally by filing the blade or grinding it carefully so as not to draw the temper. Bearings should be kept greased and adjusted snugly, or replaced if necessary, so that the blade runs true and vertical. If the shank or yoke becomes bent it should be straightened or replaced, unless the blade can be brought to correct position by shims under the colter clamp. A colter that leans sideways or does not run straight forward may crowd the plow toward or away from the furrow so that it fails to respond to changes in the hitch. A colter that wobbles may cause these troubles and also permit trash to wedge between the jointer point and the colter.

Proper setting of the colter depends on field conditions, and changes must be made to suit these conditions. Ordinarily the blade should cut ½ to 1 inch wider than the share and should cut about ⅔ of the depth of plowing when plowing less than 6 inches deep. It should be 3 to 4 inches for deeper plowing. In soft or easy plowing the hub of the colter may be ahead of the point, while in hard plowing it may be necessary to set it back of the point. Where stones are common, the colter of a light plow is sometimes set ahead and as deep as possible, so that the edge of the colter helps to protect the point of the share, rolling it out and over the stone with less injury to the plow than if the point had struck. When plow and colter are working properly a full, straight furrow wall is formed and provides good bearing for the rear wheel or landside. A ragged furrow wall is usually due to narrow or shallow setting of the colter or wrong setting of the plow hitch. Considerable pressure is needed to force the rolling colter into the ground; to provide this, the hitch should be set a little higher on the bridle of a horse plow than if no colter were used.

The Moldboard Jointer

The jointer point should be shaped about as shown in figure 6 so that when it rests lightly against the colter there will be a V-shaped clearance space back of the point. This permits bits of trash that lodge against the jointer edge to work their way out, and provides for taking up slight wear on the point by twisting it toward the colter. As wear increases other adjustments

must be made. For this purpose some jointers are provided with a slot in the frog to allow the blade to be swung toward the colter. In other types the blade back of the point may be ground to give clearance. Some types of jointers have cheaply replaceable points.

The jointer should be set just far enough behind the colter hub to prevent dirt and trash wedging against it, and low enough to cut a three-cornered ribbon of dirt about 4 inches wide and usually not more than 2½ inches deep at the point. The cutting edge of the jointer should not be completely buried, since in that case the slice of dirt would not be cut free. In setting an independent jointer care should be taken not to crowd the colter, as this will keep the colter from turning and may make the plow run unsteadily.

When a jointer is used without a rolling colter, its point should be set approximately over the point of the share (fig. 2). It should cut ⅜ to ¾ inch wider than the plow and 1½ to 2½ inches deep.

Sometimes the jointer fails to scour or throws trash against the next beam of a gang plow. This may be prevented by twisting the jointer or by tilting it forward or backward. Most jointers have adjustments that permit these changes.

The Disk Jointer

The center of the disk jointer should be approximately over the point of the share. Usually it should cut 2 or 3 inches deep, and the angle of the disk toward the furrow should be so set that its slice just clears the next bottom or the furrow wheel.

Chains and Covering Wires

A log chain is a valuable aid in covering trash with walking plows.

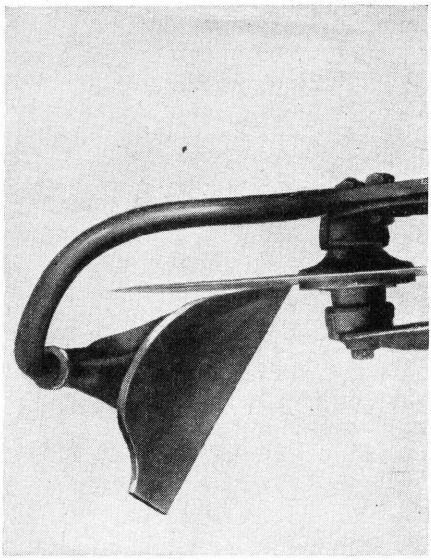

FIGURE 6.—Top view, showing shape and proper setting of jointer point against colter blade.

One end is fastened to the doubletree back of the furrow horse and the other to the plow beam (fig. 2). The chain is allowed to drag back almost to the plowshare, forming a loop that will drag the trash under the turning furrow slice without the chain itself being caught. A short length of heavy wire fastened to the loop and dragging back under the furrow helps to hold the chain in position. Some experimenting may be necessary in order to adjust the chain properly.

On wheeled plows, covering wires instead of chains are generally used. These are pieces of heavy soft-iron wire 10 to 12 feet long (fig. 7). One covering wire is usually tied to the lower end of each colter shank (fig. 8), the wire running back over the lower part of the furrow slice and under the turned soil. Sometimes it is advantageous to pass this wire through the colter yoke to regulate its height. Another wire is fastened to the axle or hitch to drag just over the furrow wall, and additional wires are often fas-

FIGURE 7.—Plow equipped for clean plowing. Note ample clearance, large rolling colters, jointers, and covering wires.

FIGURE 8.—Method of attaching covering wire to colter shank and plow axle.

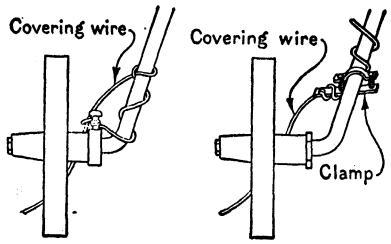

FIGURE 9.—Method of fastening wires rigidly to plow axles in order to avoid swinging when making turns.

tened to the plow frame or axles. Each wire should drag far enough under the furrow slice to give it sufficient tension to hold trash down and to bend over long pieces that would otherwise not be covered. All wires should be fastened rigidly to reduce swinging, so they will not drag under the plow bottoms when making turns with the plow lifted (figs. 8 and 9). Kinks may cause the wires to tangle and drag trash or to break. It is a good idea to keep a few extra wires on hand.

FIELD ADJUSTMENTS

A plow, to do its best work, must be adjusted to suit soil conditions. Adjustments should be made from time to time because there are variations in the soil on different parts of the farm, and from season to season as rains occur and crops are rotated. The necessary field adjustments can be made quickly and easily, and the behavior of the plow is the best guide to adjustments that should be made.

Since the entire power of the team or tractor is applied to the plow through the hitch, no other adjustment can entirely remedy the fault if the hitch is wrong. Poor work, excessive wear on the shares, and wasted power are likely to result. The hitch should be so set that the plow runs level at the desired depth and width of cut, without much guidance from the wheels or from the handles in the case of a walking plow.

HORSE PLOWS

Depth

The depth cut by a walking plow in good condition is affected by the height of the team, the length of the traces, the height of the cross clevis above the furrow sole, and the weight of the eveners. When plowing, a horse works most comfortably if the traces are moderately long. The theory that a short hitch saves power does not necessarily apply to the plow. What the short hitch actually does is to raise the front end of the plow and cause it to run shallower unless the height of the cross clevis is changed to compensate.

Depths adjustments should be made by moving the cross clevis (fig. 10, *a*) up or down on the plow bridle (beam clevis, fig. 10, *b*). The higher the clevis pin (*p*) is above the bottom line of the share the deeper the plow will run. Since these adjustments of the walking plow are simple and generally understood, they give little trouble in ordinary ground as long as the share is in good condition. If the share

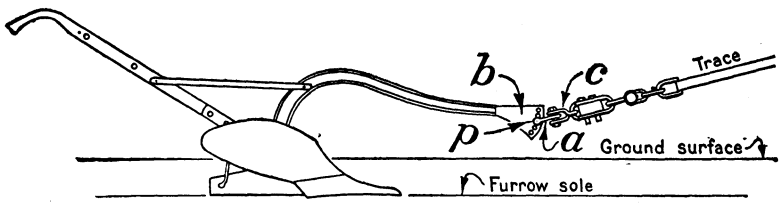

FIGURE 10.—Depth of plowing depends chiefly on height of clevis pin (*p*) above line of furrow sole: *a*, Cross clevis; *b*, beam clevis; *c*, twisted clevis.

becomes badly worn, the plow may fail to penetrate when the hitch is in ordinary position, especially in hard ground. The only satisfactory remedy is to put on a share with a good point.

The hitch of a sulky or gang plow, or of a walking plow with beam wheel, should be adjusted for depth just as that of a plain walking plow. The wheels should be set to steady the plow and hold it at uniform depth across soft places. When the hitch of a wheeled plow is properly adjusted, the rear wheel should carry about the same weight as either of the others. One way to test height of hitch is to hold the land-wheel lever unlatched for a short distance. If the hitch is properly adjusted, the operator should be able to hold the plow at the desired depth with little effort. If the hitch is too high on the bridle, there will be too much weight on the front wheels and the plow will tend to run deep as soon as the lever is unlatched. On the other hand, if the hitch is too low on the bridle the plow will not run deep enough.

Width

The number of horses hitched abreast, the length of the eveners, and the way the horses are reined affect the running of a plow. For best operation the main evener clevis should be near a line centered on the plow beams (line of draft of bottoms, fig. 11) and the horses should be reined to walk straight ahead.

When a 14-inch plow is hitched behind a two-horse team, and a 38- or 40-inch evener is used, the width adjustment is very simple. If the plow is not cutting wide enough, the twisted clevis (fig. 10, *c*) should be moved nearer to the open furrow on cross clevis *a*. If it is cutting too wide, clevis *c* should be shifted away from the open furrow. There is very little side draft in this case, because the center of the doubletree is almost in line with the plow beam. The same principle applies to sulky and gang plows, but where four horses are used abreast on a gang plow, side draft will cause more or less trouble. This difficulty is illustrated in figure 11. In order that the two-bottom, 14-inch plow may pull straight ahead with least draft, clevis *c* should be set on the line of draft of the bottoms, about halfway between the plow beams, probably 19 inches from the furrow wall. But this is not possible with three horses on the land, because the center of the evener will be 28 or 30 inches from the furrow wall even though short singletrees are used. Therefore, to limit the plow to its proper width of cut it is necessary to hitch several inches off center, as shown. Hitching to the corner of the plow in this way tends to pull it cornerwise instead of straight ahead, just as if the team were hitched to the corner of a harrow instead of at the center. The front-furrow wheel may be set at an angle, as shown in figure 11, to help overcome this tendency, but power is wasted and the horses are crowded and worried. The difficulty may be overcome by using a

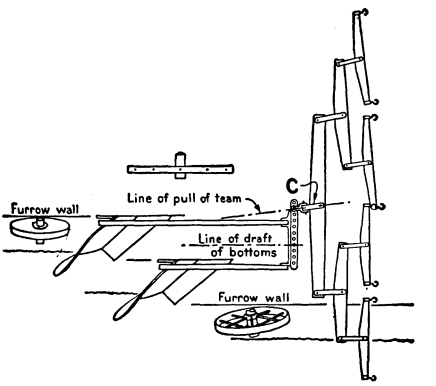

FIGURE 11.—Hitching 4 horses abreast to a 2-bottom plow results in side draft.

tandem hitch; that is, with 2 or 3 horses on the rear evener and 2 ahead.

Set of Wheels

Properly adjusted wheels tend to hold a plow steady with little attention from the operator. They help to overcome the effects of side draft and to lighten the load on the team or tractor. Quality of plowing, especially with gang plows, may be greatly improved by using the levers controlling the wheels to keep the plow level and the furrow crowns uniform. The front-furrow wheel of a horse plow serves as a width gage. On some types it may be moved in or out to change the width of cut. If side draft causes the plow to pull toward the open furrow, this wheel may be set to lead to the "land" as in figure 11.

Two types of rear-furrow wheels are used. Either should be set below and outside the landside enough to carry practically all of the side and vertical pressure at the rear of the plow, and should be angled slightly away from the furrow wall. One type, known as rolling landside, is held in a fixed position by a strong bracket. The other type is adjustable and its proper setting depends on soil conditions and on the design of the plow. Ordinarily there should be room to slip the fingers under the heel of the landside. In waxy soils it may be advisable to give less clearance under the landside, while in hard ground, slightly greater clearance may improve penetration. Proper setting of an adjustable rear wheel is often neglected, with consequent loss of efficiency. Manufacturers' instruction books give correct settings for their plows.

TRACTOR PLOWS

When a towed-type tractor plow is running properly the weight is distributed almost evenly on each front wheel and on the rear wheel or landside. The plow does the best work and pulls easiest when set this way. Proper setting of the plow hitch and the tractor drawbar are explained in the following paragraphs.

Setting the Hitch for Depth

Four common types of hitch used on tractor plows are shown in figure 12. The same principles govern the setting of all. The hitch should be adjusted for the depth of cut by raising or lowering bolt p at the rear end of the floating link l. Raising p causes the plow to run

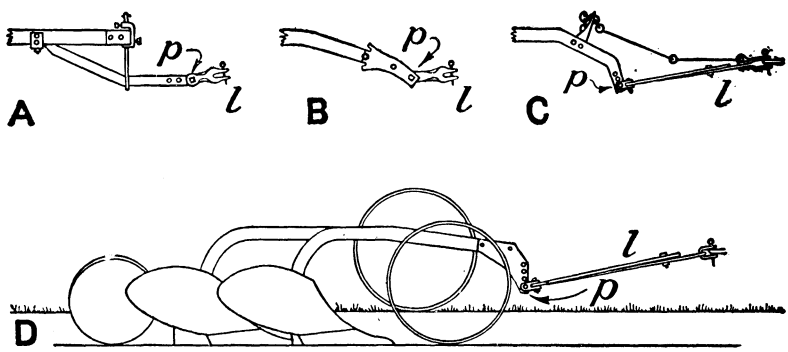

FIGURE 12.—Four hitches commonly used on tractor plows. The height of the bolt (p) above the bottom of the shares, and the height of the tractor drawbar control the depth to which the plow tends to run. The floating link (l) may be set higher for greater depth of cut.

deeper unless the wheels prevent, and lowering *p* makes the plow run shallower, as in the case of the horse plow (fig. 10).

If the plow runs unevenly or fails to hold the depth for which the wheels are set, the shares should be examined to determine whether the points are in good condition. If the points are good, the tractor drawbar may be lowered. If this does not remedy the trouble, the hitch may be raised slightly on the end of the plow beams (fig. 12, *p*). For penetration it is better to set the tractor drawbar low than to hitch high on the plow, as raising the plow hitch too high in an effort to make dull shares penetrate may result in "nosing," as shown in figure 13, *A*. On the other hand, if the plow tends to run too deep and the front wheels are carrying too great a load, the levers may be hard to shift. In that case the hitch at *p* should be lowered; then, if necessary, the tractor drawbar should be raised until all three wheels carry about the same load. Raising the tractor drawbar too high will make the tractor difficult to steer.

The full-floating type of hitch (fig. 12, *D*) allows the plow to be carried on all three wheels when lifted. Hitches like that shown at *C* have a chain or rod which holds the front end of the plow down and the rear end up when the plow is lifted, so that all the weight is carried on the two front wheels.

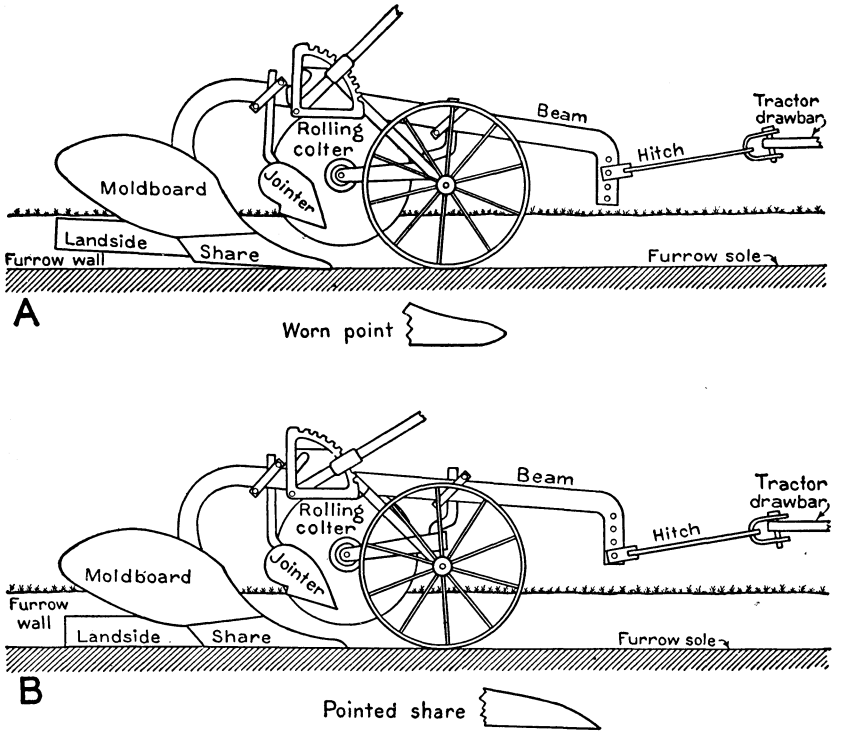

FIGURE 13.—Good shares and proper hitch adjustments are necessary for good work. *A*, Share with worn point fails to penetrate ground properly. Hitching high on beams to force plow deeper throws it "on its nose," with landside riding up. *B*, A correctly pointed share draws the plow into the ground. The hitch should be set low enough at beams to hold the plow level and in balance at the depth desired.

304973°—54——3

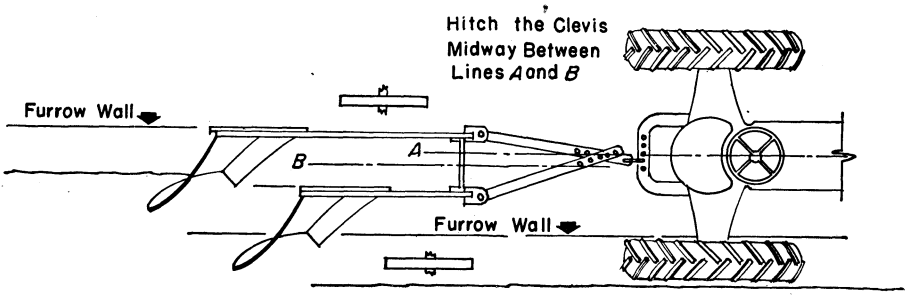

FIGURE 14.—There is little side draft when a 2- or 3-bottom plow is drawn behind a standard-width tractor. For best results, hitch point on tractor should be midway between lines *A* and *B*, as shown.

Hitches like *A* and *B* act in the same way as that of *C* because the link *l* is short. Plows with hitches of this type are usually referred to as two-wheeled plows, though, as previously mentioned, such a plow frequently has a rear wheel mounted on a rigid bracket and known as a rolling landside. During plowing it carries the load at the rear of the plow. The hitch setting should be the chief means of controlling depth, and levers should be used only to accommodate the plow to soil differences in the field and to hold the plow level crosswise.

The methods of adjusting direct-connected plows for both width and depth will vary with the type and make of plow. The principles explained above will have their application, although the adjustments will not be so obvious. The manufacturer's instruction book should be followed in making adjustments.

Dividing Side Draft

Hitching off center on either the plow or the tractor causes side draft. The amount of side draft and the trouble it may cause depend on the draft of the plow and the distance that the hitch is off center. (See fig. 11 and the discussion of the side draft in horse plows, p. 13.)

The line of draft of the bottoms (line *B*, figs. 14 and 15) is approximately midway between the beams in the case of a gang plow or in line with the beam of a single-bottom plow. If this line of draft is almost directly behind the center of the tractor (line *A*, fig. 14), as when a two-bottom, 16-inch plow is drawn by a standard-width tractor, side draft will cause little trouble. It is more likely to cause difficulty when a wide-tread, general-purpose tractor is used with a

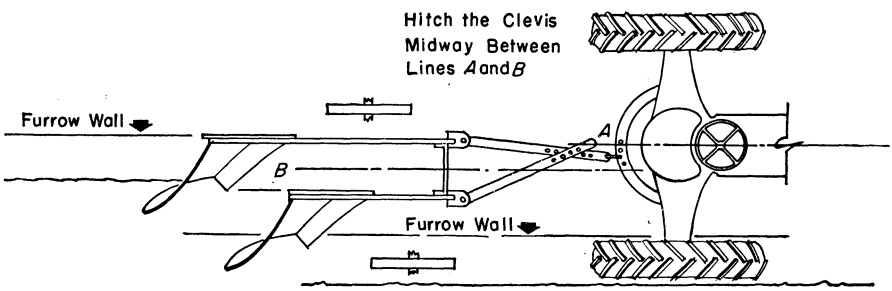

FIGURE 15.—Plow drawn by a wide tractor. The side draft should be divided between plow and tractor by setting tractor drawbar halfway between center line of tractor and line of draft of plow bottoms, as shown.

relatively narrow plow (fig. 15), especially when the ground is hard and the draft is heavy.

If the plow is relieved of side draft by hitching the clevis on the drawbar near line *B*, the tractor may be pulled sidewise. On the other hand, if the tractor is relieved of all side draft by hitching the clevis in the middle hole of the drawbar, the plow will probably pull cornerwise and run poorly. The best remedy for these difficulties, if much plowing is to be done, is to set the tractor drive wheels closer together to bring the center line of the tractor as close as possible to the line of draft of the plow bottoms. This can be done on the newer general-purpose tractors in several ways, as by reversing wheels with offset hubs, by sliding wheels on the axle, or by means of telescoping axles.

If it is not possible to narrow the tractor tread, the plow clevis may be hitched midway between the center drawbar position and the line of draft of bottoms, as indicated in figure 15, and an adjustment made for width of cut. If the plow tends to pull cornerwise, the clevis on the drawbar may be shifted nearer to the line of draft of bottoms, thus putting more of the side draft on the tractor, then readjusting for width of cut. On the other hand, if the front or rear wheels of the tractor are pulled sidewise to an objectionable degree, more of the side draft may be shifted to the plow by moving the clevis toward the center of the drawbar and readjusting for width. If the difficulty cannot be overcome in this way, it may be necessary to lengthen the plow hitch.

Adjusting for Width of Cut

Adjustments for width of cut should be made on the plow hitch and not by shifting the tractor drawbar or the point of hitch on the drawbar.

On plows having a V-type hitch (figs. 14 and 15) one side of the V should be lengthened or shortened. Some plows are provided with an offset clevis (fig. 12, *B*) that may be set to the right or left on the end of the beam or turned upside down, giving four width settings. Other plows have a pivoted hitch bar with a clamp on the front cross member of the plow (fig. 12, *A*) that holds the hitch at the proper width and depth setting.

Setting Wheels and Levers

The information on page 14 concerning proper setting of wheels and levers for horse plows applies also to tractor plows, except that the front furrow wheel of a tractor plow is not intended to run against the furrow wall to gage the width of cut, nor can it be set at an angle. It may be repeated that close attention to the levers improves the uniformity and appearance of the work.

Safety Hitches

An overload release should be used at all times when plowing. Break pins are fairly satisfactory where obstructions are few. The bolts in the slotted holes behind or in front of the break pin should be tightened just enough to prevent excessive wear on the pin.

Many of the newer tractor plows are equipped with spring-controlled releases. Two types of these are available. One type must be reset by hand, while the other snaps back to working position automatically and the plow may be recoupled from the tractor seat. There are also safety releases that attach to the tractor drawbar.

The release, whether spring or break-pin type, should be kept in

good working order and so adjusted that it will function before the plow is subjected to severe strains. *Bolts should not be substituted for wooden break pins.*

FIELD PRACTICES

Plowing should be done when soil-moisture and weather conditions are suitable. At such time it is easier to keep the plow running properly, less fuel is used, and less time is required. In many sections it is good practice to plow in the fall and avoid the chance of wet weather or lack of time in the spring. Land that is subject to erosion by wind or water, however, should not lie bare any longer than necessary.

LAYING OUT FIELDS

Finishing a wedge-shaped piece of land is troublesome and wastes time. Such shapes can usually be avoided except in irregular fields. It is not necessary to measure off lands each season if the field is once laid out accurately and marked with permanent stakes set in fence rows. It is then easy to place back-furrows in last season's dead furrows and keep the field level, or if dead furrows are needed for drainage they can be kept straight and left open. Different methods of laying out lands are described in Farmers' Bulletin 1045, Laying Out Fields for Tractor Plowing, and many of the suggestions apply also to plowing with horses.

PLOWING SPEEDS

The proper speed for plowing depends on the condition of the soil and the type of bottom used. When a tractor is overloaded the speed may be reduced enough to lower the quality of the work done. The plow should be pulled with sufficient speed to turn the furrow slice over completely. This results in a wider open furrow to hold trash, and usually is a cleaner, smoother job than is obtained at lower speeds. In new or stony ground where the plow is likely to strike solid objects, it is usually advisable to avoid high speeds and when plowing with a tractor to use a safety release in the hitch.

CLEAN PLOWING

The following pages are devoted to the special precautions that should be observed when selecting and operating plowing equipment where clean plowing is especially desirable, as where the European corn borer or certain other insect pests are present.

CHOICE OF EQUIPMENT

Field tests show great differences in the covering ability of plows. Therefore, when a new plow is being purchased, its ability to plow cleanly should be considered with special reference to the features discussed in the following paragraphs. Clean plowing depends as much upon the operator as upon the plow, and good work can be done with most of the plows now in use, provided they are equipped with suitable covering attachments and are adjusted as has been described.

The choice between tractor power or horse power for plowing depends more on other factors than on requirements for clean plowing. The operator of a horse-drawn plow is in an excellent position to watch its work and to keep it operating uniformly. When there is a tendency to clog he can see it and dislodge the obstruction at once. On the other hand, tractor plows usually have greater clearance, are equipped with more effective covering attachments, and operate at higher speeds than horse plows.

All these qualities tend to improve coverage.

Single-bottom plows are satisfactory for small acreages. Some plows having more than one bottom, especially in the smaller sizes, lack clearance and are impeded considerably by clogging, or do not have room enough for the proper attachment and operation of colters and jointers. Plows having more than two bottoms do not turn uniform furrows where the field has been ridged by cultivation unless the ridges are first leveled by disking. These factors favor two large instead of three small bottoms of equivalent width.

On mellow soils the larger bottoms, such as 16- and 18-inch, usually do cleaner plowing than smaller bottoms; but on heavy or waxy soils some large bottoms leave the ground very rough, with breaks in the furrow slice. Under such conditions, where small bottoms must be used to turn the soil smoothly, it is often best to dispose of trash before plowing.

Shape of plow bottoms is just as important as size. The bottom should make a wide, open furrow to hold the trash turned by the following bottom or at the next round, and should turn the furrow slice over completely and uniformly. Small differences in plow shapes are difficult to distinguish. A good way to select a suitable type of bottom is to see it in operation or, better, to give it a thorough trial in the soil where it is to be used.

COVERING ATTACHMENTS

To do clean plowing in cornstalks or other crop debris, plows must be equipped with auxiliary covering attachments (pp. 3 to 6). These devices work in front of the turning furrow slice to move cornstalks or other trash toward the open furrow. It is, therefore, very important to have enough clearance at the points where clogging occurs, as shown in figure 16, to permit these devices to do their work and permit trash to pass through without interference. It is desirable to have a minimum horizontal distance of 21 inches or more measured diagonally from the top of the moldboard at the shin to the back of the beam ahead, or to the tire of the furrow wheel. The axles and braces should be so placed that there is room for the use of colters as large as 18 inches in diameter. Both plow and hitch should be free from projecting parts that might drag trash. Provision should be made for easy adjustments.

The necessity for using covering attachments in order to do a good clean job of plowing in whole cornstalks or almost any kind of trash was demonstrated by an experience with a two-bottom 14-inch plow in a field of standing stalks. After plowing, 25 bushels of trash per acre were picked up from the land where no covering attachments had been used, while only 2½ bushels per acre were left where rolling colters, moldboard jointers, and covering wires (fig. 7) had been used. These attachments may be used together satisfactorily under most soil conditions, although some difficulties are encountered with moldboard jointers in soils that do not scour well.

Some of the trouble experienced with jointers is due to worn points and may be avoided by keeping the points in good repair and properly adjusted against the colter (fig. 6). Small or dull colters that fail to cut the stalks, especially when they are damp and tough or when the soil is soft, also interfere with the operation of the jointers. Large sharp colters remedy this fault. Lack of proper clearance between the plow bottoms is likely to cause stalks to clog against the jointers. This diffi-

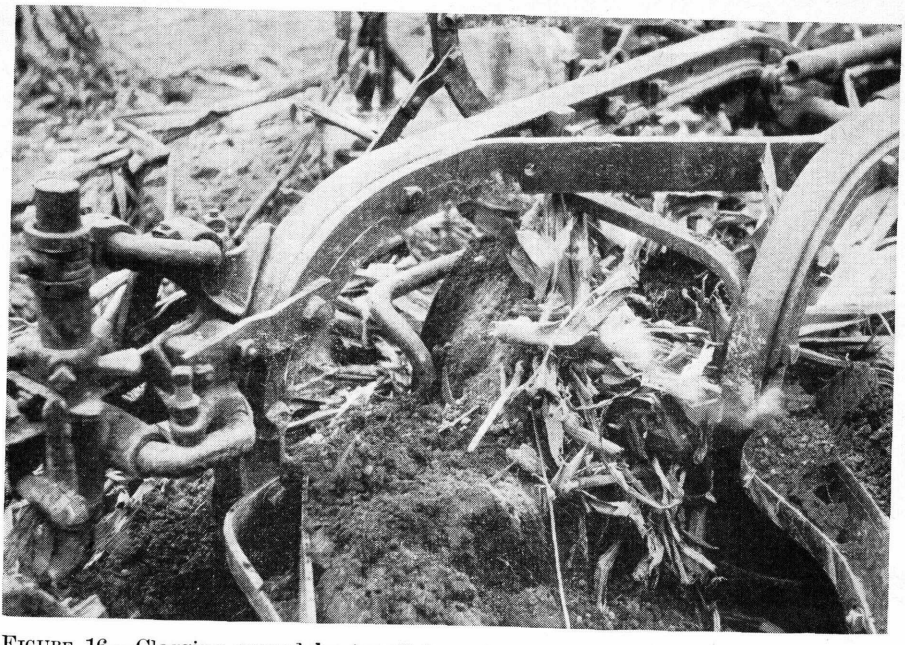

FIGURE 16.—Clogging caused by insufficient clearance between the jointer and the bottom ahead of it.

culty seldom occurs when plows have 21 inches or more of clearance between the top of the moldboard and the beam ahead. Disk jointers and covering wires may be used together satisfactorily in plowing under cornstalks. It is likely that they can be used under more adverse soil conditions than moldboard jointers. Types of trash shields that are free from clogging may be used satisfactorily with either type of jointer.

Rolling colters and covering wires or trash shields may be used together without jointers, but the work will not be so clean as when jointers are used also. Covering wires or chains are sometimes used alone but are not sufficient to do clean work.

The jointer and chain may be used satisfactorily on walking plows (fig. 2) without the rolling colter, because the operator can easily free the plow of stalks that may catch on the jointer shank. This arrangement of attachments is often used where the soil contains large stones that might catch between the colter and plowshare or force the plow out of the ground if a standard rolling colter were used.

PRACTICES THAT PROMOTE CLEAN PLOWING

Disposing of crop refuse may be made easier by simple precautions in other field operations. For example, cultivation that does not ridge the soil permits better plowing for the following crop and also is helpful if other methods of trash disposal are used. Ridging is more likely to result when corn is drilled than when it is planted in checkrows, but the root clumps of single stalks are less troublesome than those of stalks growing in a hill. It is usually easier to do clean plowing where the corn has been drilled, provided the ridges are low.

Disking before plowing may be harmful if done when the soil is in condition to pack. When the

field is dry, however, disking with a sharp, weighted disk breaks up the crust, reduces ridges, and cuts up stalks. Under these conditions, the plowing may be improved and the number of stalks uncovered in cultivation will usually be reduced.

Pasturing cornstalk fields reduces the quantity of trash to be turned under, but the soil may become packed by livestock tramping over it when wet, and this makes good plowing difficult.

Stubblefields to be plowed with a walking plow are often first rolled or dragged with a weighted drag. If one operation is not enough to break the stubble down, it should be repeated in the opposite direction. Lands to be dragged should be laid out the same as plowlands, and in going over them the last time the implement should travel in the same direction as the plow in order to leave the stubble pointing forward. If a tractor is used, an extension rim on the land wheel will break down stalks and stubble.

Mechanical corn pickers usually leave the stalks in good condition to be turned under if the plowing can be done in the same direction that the picker traveled and if the stalks are not pulled loose. It is rather difficult to plow in the opposite direction until the stalks have weakened by being weathered through the winter, or cut up with a disk harrow or stalk cutter.

Sometimes it is impossible to do clean plowing in whole cornstalks, either because of soil conditions or use of a poorly equipped plow. In such cases, if the control of the European corn borer is an object, removal of stalks may be necessary. This should be done before plowing, for picking up uncovered stalks by hand after plowing is a backbreaking job. Removing or burning stalks or debris is suggested only as a last resort. Under most conditions such material should be incorporated into the soil if at all possible.

Where surface drains are not needed, it is good practice to place backfurrows in the old dead furrows to keep the field level, or to plow around the entire field, thus reducing the number of backfurrows and dead furrows.

It is best to remove cornstalks from headlands before plowing. Stalks standing where backfurrows are to be placed may be cut and thrown aside or raked up and burned, preferably before the weather is suitable for plowing, so that no time is lost.

If crop refuse has not been removed, the backfurrows may be prepared for plowing by running the disk harrow on each line, then returning in the same path. If a tandem disk is used, the rear gangs should be set straight to avoid filling up the depression made by the front gangs. This depression is needed to hold trash turned by the plow at the first round and also helps to keep the backfurrow level. Sometimes trash on the line of the backfurrow is mashed down by the tractor drive wheel before making the first round. This improves the looks of the backfurrow, but disking or harrowing after plowing may uncover much of the trash. In finishing dead furrows, the work should be so managed that if the land has been ridged by cultivation the last furrow thrown each way will be cut from between the ridges.

It is usually necessary to plow at least 6 inches deep in order to place trash so far under the surface that it will not be dragged out by the operations of fitting, seeding, or cultivating the ground. For the purpose of covering trash, it is better to plow 7 to 8 inches deep if possible. Plowing deeper than 8 inches usually results in little or no improvement in coverage, except perhaps in sandy soils. Where

rock ledges prevent the plow running 6 inches deep, trash over the ledges should be removed before plowing. It may be scattered over the adjoining land and plowed under, or it may be burned.

PRECAUTIONS TO BE TAKEN AFTER PLOWING

When mellow soils are properly plowed, the trash is well buried and the furrows form a continuous granular surface that may easily be worked into a seedbed. On the other hand, heavy soils are often turned up by the plow in large clods or lumps with open spaces between. Trash may be so poorly covered by these clods that the operation of fitting the seedbed will drag pieces to the surface or leave them partly exposed. Under these conditions a corrugated roller, a packer, a spike-tooth harrow, or a plank drag may be pulled in the direction of plowing to break up the clods and fill the holes before the ground is worked with other implements.

The disk harrow should be used with care in preparing a seedbed where trash has been plowed under, since disks set at too great an angle turn up much buried material. The disks may be set at a slight angle and weighted to obtain penetration. If a spring-tooth or a spike-tooth harrow is used it should be run shallow.

U. S. GOVERNMENT PRINTING OFFICE: 1954